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ADVENT PROGRAM
FINAL REPORT

PREPARED FOR
AIR FORCE SPACE SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
INGLEWOOD, CALIFORNIA

L/C AF04(647)-828
D/C AF04(695)-112

PHILCO

WESTERN DEVELOPMENT LABORATORIES
PALO ALTO, CALIFORNIA

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WDL-TR1995
30 January 1963

**ADVENT PROGRAM
FINAL REPORT**

Prepared by

**PHILCO CORPORATION
Western Development Laboratories
Palo Alto, California**

L/C AF04(647)-828
D/C AF04(695)-112

Prepared for

**SPACE SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Inglewood, California**

PHILCO

WESTERN DEVELOPMENT LABORATORIES

ABSTRACT

PHILCO WDL-TR1995
ADVENT PROGRAM-
FINAL REPORTS
30 January 1963

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70 pages including illuats.

AF04(647)-828

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This final report contains a historical account of Philco WDL's participation in the Advent Program.

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FOREWORD

This final report contains a historical account of Philco WDL's performance on the Advent Program and is submitted as a result of direction to terminate the Advent Program in the most economical manner by 31 December 1962.

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TABLE OF CONTENTS

<u>Section</u>		<u>Page</u>
1	INTRODUCTION	1-1
	1.1 Program Inception	1-1
	1.2 Responsibilities	1-1
	1.3 Problems.	1-2
	1.4 Re-Direction	1-2
	1.5 Philco Direction	1-3
2	ADVENT PROGRAM ORGANIZATION	2-1
	2.1 Overall Advent Management	2-1
	2.2 Philco WDL TT&C Management.	2-1
3	PHILCO WDL TRACKING, TELEMETRY AND COMMAND SYSTEM	3-1
	3.1 Description	3-1
	3.1.1 System	3-1
	3.1.2 Equipment	3-3
	3.1.3 Installation and Checkout	3-6
	3.2 History	3-8
	3.2.1 Technical Chronology	3-8
	3.2.2 Contractual Chronology	3-15
	3.2.3 Installation and Checkout Chronology	3-19
	3.3 Documentation	3-31
	3.3.1 Specifications	3-31
	3.3.2 Engineering Equipment List	3-32
	3.3.3 Drawings	3-33
	3.3.4 Reports.	3-34
	3.3.5 Technical Manuals	3-37
	3.3.6 Film Reports	3-40
	3.4 Support	3-41
	3.4.1 Reliability	3-41
	3.4.2 Minor Modifications	3-42
	3.4.3 Training	3-43
	3.4.4 Personnel Planning	3-44
	3.4.5 Studies.	3-44
	3.4.6 Logistics	3-45
	3.4.7 Security	3-46
4	COMPLETION	4-1
	4.1 General	4-1
	4.2 Aerospace Ground Equipment	4-1
	4.3 Satellite Test Annex	4-2
	4.4 HTS	4-2
	4.5 Fort Dix Station	4-2
	4.6 Camp Roberts Station	4-3
	4.7 Navy Advent Shipboard Terminal	4-3
5	CONCLUSIONS	5-1

SECTION 1

INTRODUCTION

1.1 PROGRAM INCEPTION¹

Following the first two successful active communications satellites, the Army Signal Corps Project "SCORE" and the Army's "COURIER", the Advanced Research Projects Agency (ARPA) of the Department of Defense was asked to study numerous concepts for a "real time" active satellite.

1.2 RESPONSIBILITIES²

A new single program to develop a synchronous satellite was initiated early in 1960 to provide for a satellite to be placed in a circular orbit, synchronous with the Earth's rotation. The satellite would hover over a specific point on Earth and provide a high capacity, wide bandwidth, multi-channel, "real time" repeater capability.

In September 1960, overall management responsibility for Project Advent was transferred from ARPA to the Department of the Army. The Advent Management Agency was established at Fort Monmouth, New Jersey (Refer to Paragraph 2.1). During the following 18 month period, the Advent Project experienced many problems which resulted in substantial overruns. Many of these problems were of a technical nature, while others were ascribed to the management arrangements that had been made, and the manner in which these were found to be working out in practice.

¹ Historical data taken, in part, from the Report of the "Committee on Science and Astronautics, U. S. House of Representatives" Eighty-Seventh Congress, Union Calendar No. 1068.

² COMSAT will be designed to operationally communicate with Ground Stations such as the Camp Roberts and Fort Dix Stations.

The remaining Philco TT&C equipment was to be installed at all sites, acceptance tested and furnished as GFE equipment for possible future support of a satellite communications spacecraft.

1.3 PROBLEMS

On three different occasions within a period of one year, reviews were made of the Advent Program by the Department of Defense. The first two reviews resulted in a recommendation that the Army management role be strengthened by transferring spacecraft development responsibility from the Air Force to the Army. This recommendation was rejected by the Director of Defense Research and Engineering. In June 1962, following the third review, DOD announced the following technical reduction and reassignment of project responsibilities:

1. Air Force to assume responsibility for development, production, and launch of spacecraft.
2. The Department of the Army to be responsible for development and operation of ground communication stations.
3. The Defense Communications Agency to be responsible for integration of ground and space components.

Originally the Atlas-Centaur booster was selected to place 1,000 pounds in a synchronous, equatorial orbit. Unfortunately, the weight of the Advent satellite increased to well over 1,300 pounds, while the capabilities of the Centaur decreased until a point was reached where an orbit was not possible without a change in one or both development programs.

1.4 RE-DIRECTION

The technical redirection of the Advent Program was of such fundamental character as to amount to cancellation of existing programs and initiation of new studies toward two separate and distinct projects:

1. Development of a lightweight satellite weighting about 500 pounds.

2. Development of a medium altitude, "minimum essential" interim system.

Finally, it was decided to determine, if possible, whether the two new proposals would tend to duplicate work being carried out by NASA's various programs such as RELAY, SYNCOM and TELSTAR.

1.5 PHILCO DIRECTION³

Due to the fact that the Philco TT&C equipment portion of the Advent Program could operationally support a satellite communication system of many types, AFSSD directed Philco WDL to continue the equipment fabrication, installation, and checkout of all ground stations.

³ Philco WDL data.

SECTION 2

ADVENT PROGRAM ORGANIZATION

2.1 OVERALL ADVENT MANAGEMENT

The overall management responsibility for Project Advent was established in September 1960 under the U.S. Army Advent Management Agency (USAAMA). Philco WDL was responsible for TT&C ground stations based on a letter contract to the U.S. Air Force Space System Division, L/C AF04(647)-828, 1 May 1961. The overall Advent Contract Management structure is shown in Fig. 2-1.

2.2 PHILCO WDL TT&C MANAGEMENT

Starting with a small group of individuals in February 1961, the Philco WDL Advent Program Office grew to an organization in July 1961 that was responsible for management, development, integration and system integration as defined in AFSSD Exhibit 61-7, 25 August 1961. The organization at that time is shown in Fig. 2-2.

Because of launch schedule slippage, equipment delivery and installation delays, and re-direction, a reorganization of the Philco WDL Advent Program Office was affected in May 1962 to accomplish the revised schedule effort. This organization is shown in Fig. 2-3.

The final Philco WDL reorganization occurred in August 1962 because of the cancellation of the Advent Program by DOD. This organization was responsible for the completion of all checkout functions at the various sites and the re-direction of all support functions for the program to affect a termination of the contract by December 31, 1962. The organization is shown in Fig. 2-4.

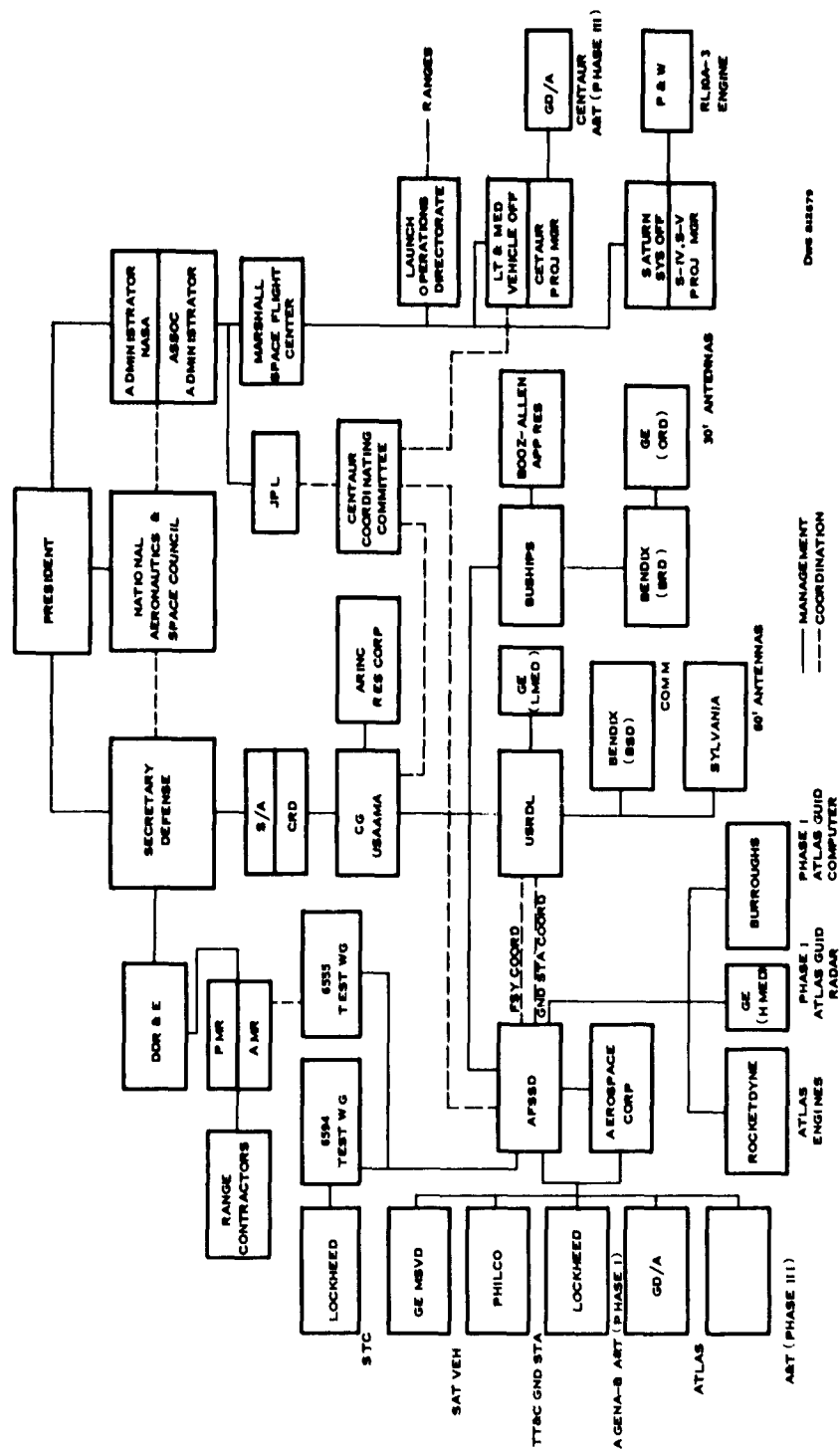
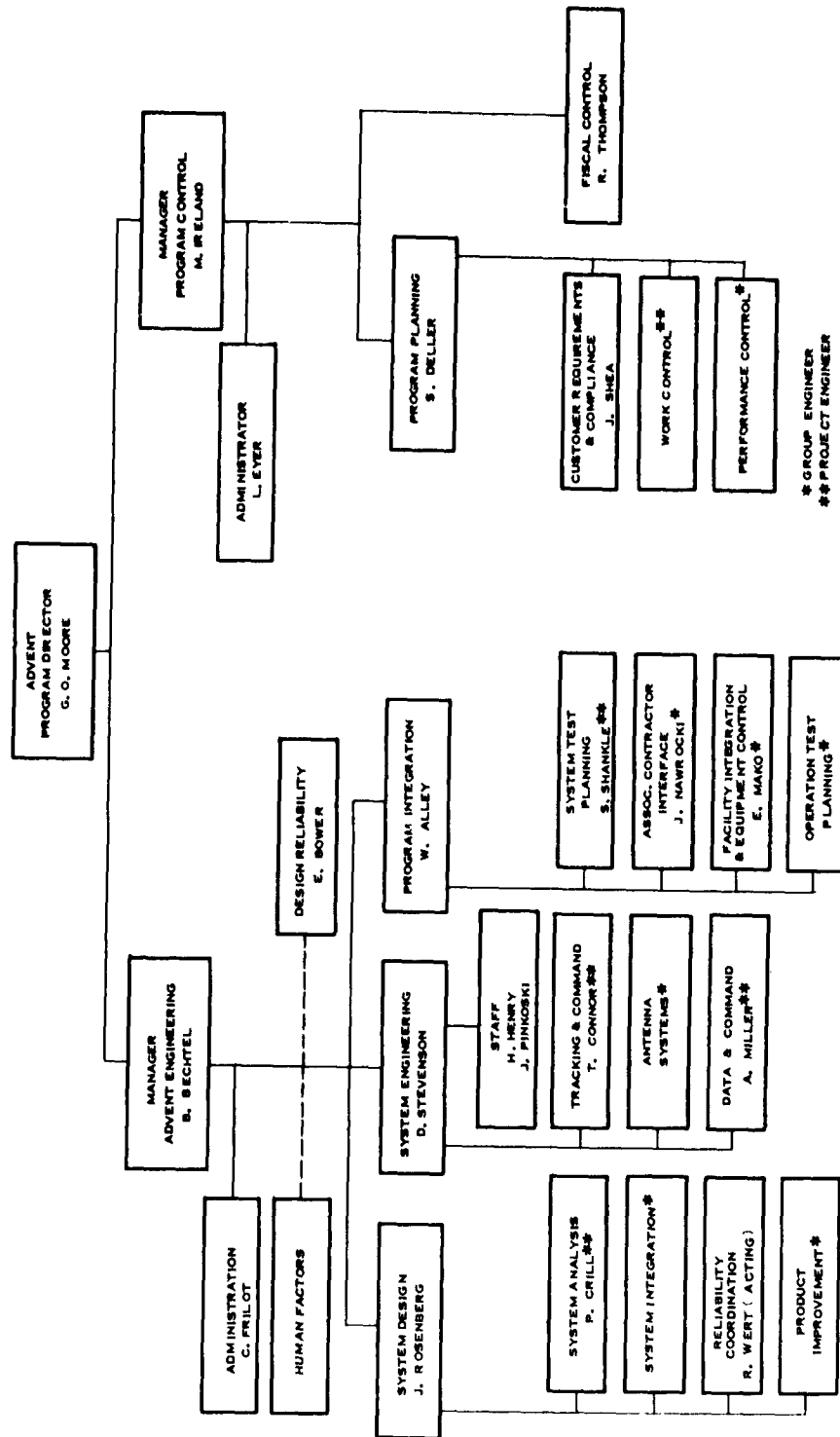


Fig. 2-1 Overall Agent Contract Management Structure



Doc # 812600

Fig. 2-2 Philco WDL Advent Program Organization (as of July 1961)

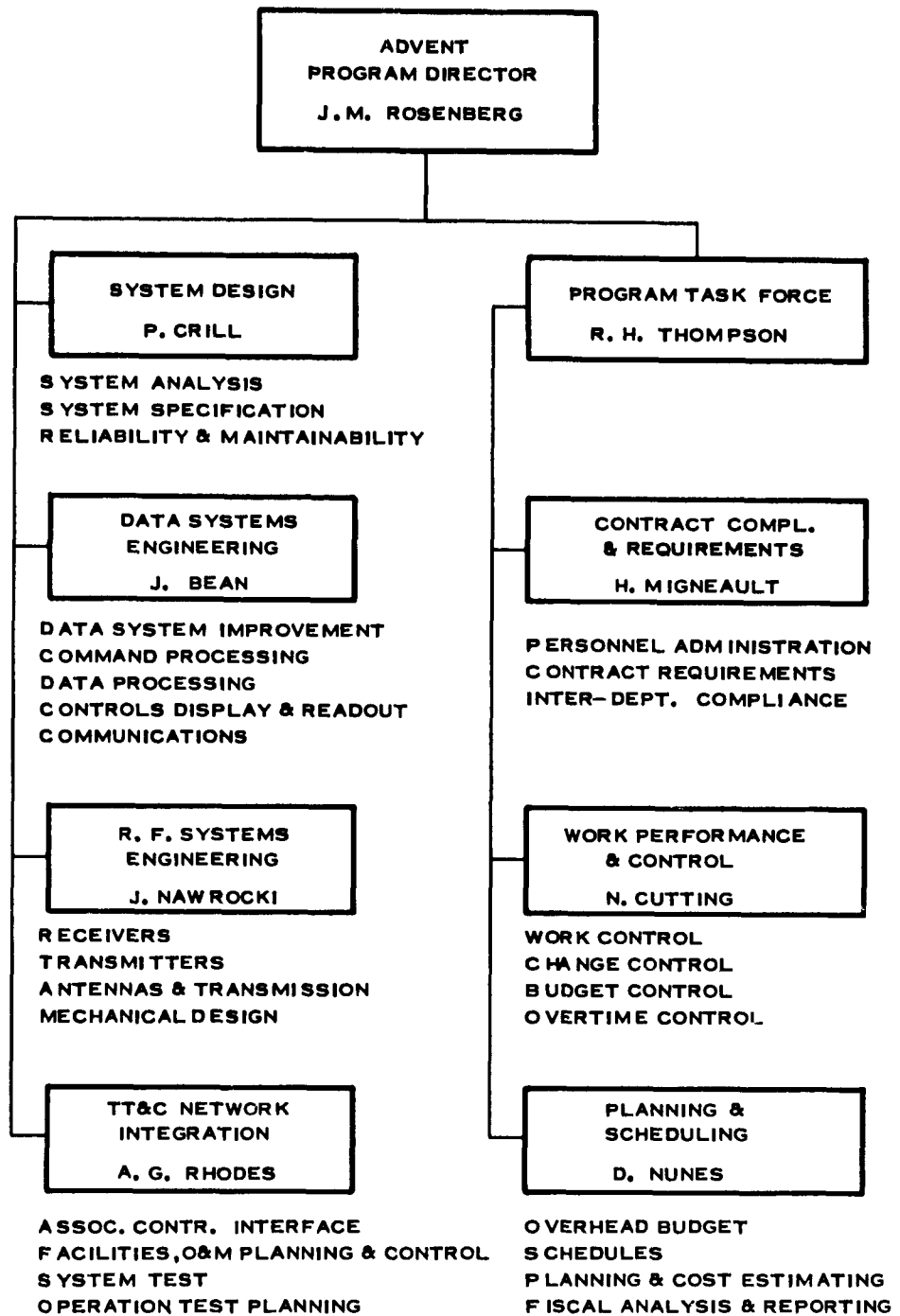
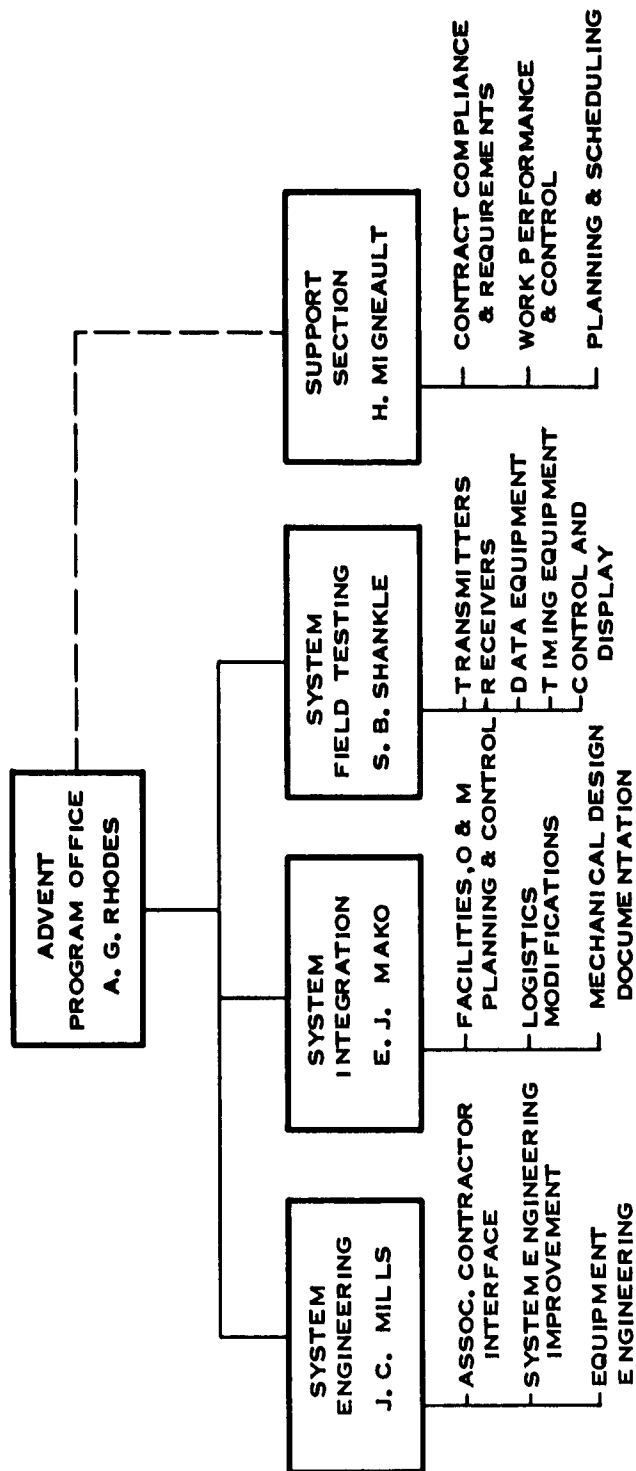


Fig. 2-3 Philco WDL Advent Program Organization (May 1962) DWG BI 2681



WDL-TR1995

DWG B 12682

Fig. 2-4 Philco WDL Advent Organization (August 1962)

SECTION 3

PHILCO WDL TRACKING, TELEMETRY AND COMMAND SYSTEM

3.1 DESCRIPTION

3.1.1 System

The Tracking, Telemetry, and Command System (TT&C), a part of the Advent Orbital Complex, comprises both satellite-borne and ground equipment that performs the following functions:

1. Provides accurate tracking data in order to determine an ephemeris with an error compatible with the requirements of orbit control. The tracking data consists of doppler data and angle data.
2. Provides an instrumentation system to monitor the performance of the satellite and provides information about the space environment.
3. Provides a command link for the orbital control of the satellite and for functional control of the communications payload and other satellite equipment.

The total Advent system consists of the Advent Orbital Complex, the Atlantic Missile Range (AMR), and the space vehicle. The Advent Orbital Complex is composed of the Advent Control Center and two functional network: the Communication Network and the TT&C Network. This complex utilized common facilities and equipment at various operational sites for both TT&C and communications functions. The general functions of the stations of the Advent Orbital Complex are as follows:

1. Camp Roberts Station, California, functions as one terminal of the Communications Networks and as a primary TT&C station.

2. Fort Dix Station, New Jersey, functions as one terminal of the Communications Network and as an alternate primary TT&C station.
3. Kaena Point Station, Hawaii, functions as a secondary TT&C station.
4. The Navy Advent Ship Terminal (NAST) functions as one terminal of the Communications Network and as a secondary TT&C station.
5. The Satellite Test Annex (STA), located in Sunnyvale, California, functions as the control point for the TT&C Network and the operations center for AFSSD orbital functions.

The general function of the Atlantic Missile Range (AMR) is a position-tracking and telemetry-receiving center for data gathered by down-range ground and ship stations during the launch phase.

In addition, Aerospace Ground Equipment (AGE) functioned as support for the Space Vehicle System at General Electric, Missile and Space Vehicle Division, Valley Forge, Pennsylvania and at Hangar A, Air Force Missile Test Center, Cape Canaveral, Florida.

Communication links between the stations of the TT&C network and the STA are required for transmission of telemetry and tracking data, command verification, etc.

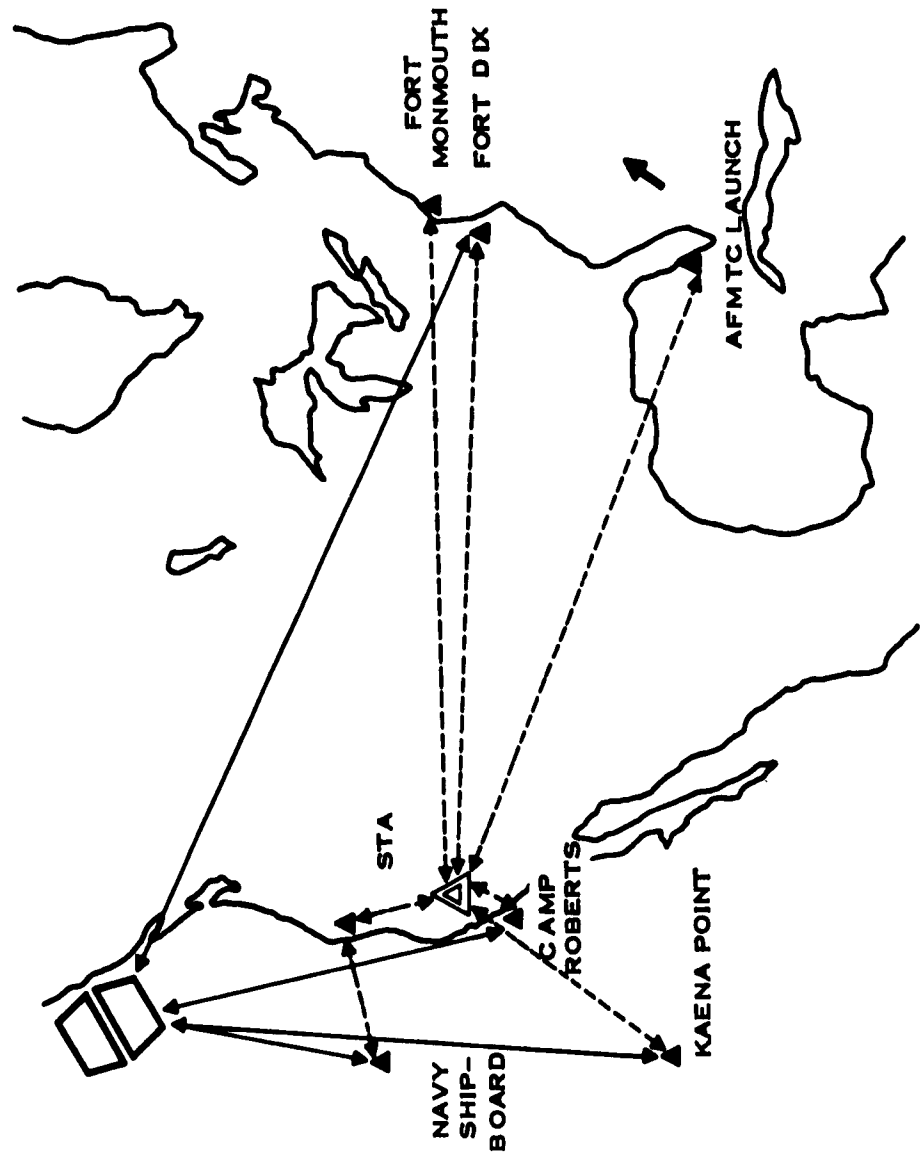
All tracking and telemetry data received at the Advent orbital TT&C stations (Kaena Point, Camp Roberts, and Fort Dix) are relayed in near real-time to the STA. A data line and teletype line are used between each orbital TT&C station and the STA. Data transmission between the Navy Advent Ship Terminal and the STA is by conventional single and multi-channel radio teletype transmission to a Navy shore station and then by a data line terminating at the STA in digital data terminal equipment. Voice and teletype communication is used between the STA and the launch complex during each launch operation.

A simplified block diagram of the TT&C operational plan is shown in Fig. 3-1.

3.1.2 Equipment

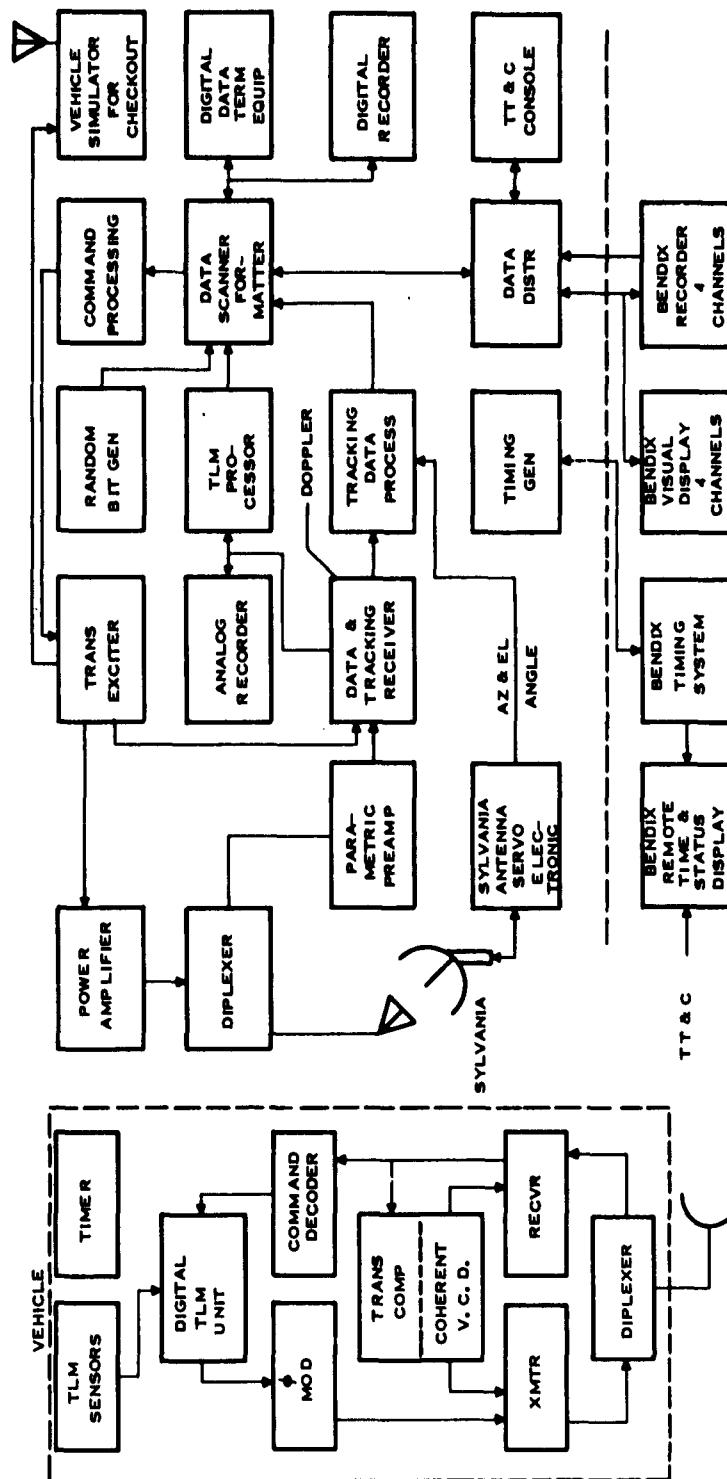
The Advent TT&C Subsystem is comprised of a number of pieces of equipment grouped into particular subsystems. The functional block diagram of a typical ground-vehicle system is shown in Fig. 3-2. Detailed explanation of each functional block is given in WDL-TR1386B, (S) "Design Summary Report," dated August 9, 1961 (revised) and in SS-1748B, Amendment 3, "TT&C System Specification." The TT&C subsystems that were designed, fabricated, delivered, installed and tested at each site, consisted of all, or a portion, of the following:

1. Advent Alignment and Calibration Subsystem - AAC
Satellite Simulator Equipment
2. Advent Antenna Subsystem - AAS
Amplifier Group
Receiver Group Filter Arm
3. Advent Control and Display Subsystem - ACD
Remote Time Display Set
Master Control Console
4. Advent Receiving Subsystem - ARS
Data Receiver Group
Recorder Equipment
Test and Monitor Equipment
5. Advent Timing and Data Subsystem - ATD
Telemetry Processor
Ground Timing Generator
Doppler Tracking Processor
Switching Unit Assembly
Command Processor Distributor
Digital Data Terminal
Data Scanner and Formatter



DWG A12683

Fig. 3-1 Advent Operational Plan



DWG 812664

Fig. 3-2 Typical Advent Ground-Vehicle System (FDS and CRS)

6. Advent Transmitting Subsystem - ATS

Transmitter and Alignment Equipment

20 KW Control-Power Supply

20 KW Klystron Assembly

1 KW Power Amplifier

The details concerning nomenclature, operating assembly, model number, site location, applicable specifications and vendor are contained in Philco WDL document "Engineering Equipment List, Advent Program," dated April 12, 1962, Revision E.

3.1.3 Installation and Checkout

Before the initial installation of Advent equipment commenced, the Philco WDL definition of I&C phases for the Advent TT&C equipment was defined in December 1961. These definitions were as follows:

1. Installation. The installation of individual equipment, including ventilation interface, power cabling, grounding, and signal and control cabling between equipment.
2. Installation Checkout. Power application to individual equipment and intra- and inter-cabinet cabling checkout to ensure operational capability.
3. TT&C Subsystem Checkout. The checkout of individual equipment comprising the TT&C subsystem to determine the operational capability of the TT&C subsystem as a whole.
4. Station Systems Integration. Integration of the TT&C equipment subsystem with other equipment subsystems, including completion of interface wiring, and combined systems checkout to assure station system compatibility and operational capability.

5. Station Operation Checkout. The integration of network equipment functions between cognizant stations of the Advent Network. The training of operating personnel and a rehearsal program to validate the integrated operational capability of personnel and equipment prior to the initial Advent mission.

Meetings were held in January and February 1962 to define Advent TT&C installation and checkout. The definitions and responsibilities of contractors and supporting agencies were established to clarify all areas pertaining to the successful completion of site installation. A document was published by Aerospace Corporation entitled "Advent TT&C Installation and Checkout, Definition and Checkout," file number AS 62.1959.4-38, 24 January 1962. This document, approved in March 1962, had the following purpose:

1. Publish a consolidated and coordinated understanding of the Advent I&C phase definitions for all sites.
2. State the responsibilities of agencies and contractors for all I&C phases at all sites.
3. Outline and define in broad terms the tasks to be performed under each phase.

Portions of this document are contained within the discussion of I&C effort, Paragraph 3.2.3 of this report.

Because of the cancellation of the Advent Program, limited Phase IV and no Phase V effort was required for the TT&C equipment at the various sites.

3.2 HISTORY

3.2.1 Technical Chronology

The following information briefly summarizes the effort of design, fabrication, delivery, installation and test of the TT&C equipment relative to the Advent ground stations. This information was obtained from the Philco WDL Advent Program Progress Technical Reports.

1. WDL-TR1581 - 20 May 1961 through 20 June 1961

- a. Major effort was expended to complete system, subsystem and procurement specifications for all TT&C equipment.
- b. Work Orders were completed for the initiation of design and development effort for Advent Subsystem Equipment.
- c. Initial findings were presented by Philco WDL on HTS antenna drive study. Modifications required to increase drive power were recommended.
- d. A Philco, GE Interface Meeting was held to exchange technical information relative to GE-AGE equipment.

2. WDL-TR1627 - 20 July 1961 through 20 August 1961

- a. The electrical design of the HTS r-f modification was completed. All critical components were ordered.
- b. Electrical design of diplexer cabinets for Camp Roberts and Fort Dix Station were completed.
- c. The design of the Master Control Console was completed.
- d. The 1-kw power amplifiers were in process of design and fabrication by Philco, Sierra Electronics.
- e. The digital data terminal equipment subcontract was let to Rixon Electronics.
- f. HTS Boresight Tower requirement was sent to AFSSD.

3. WDL-TR1667 - 20 August 1961 through 20 September 1961

- a. The fabrication of HTS engineering model diplexer was completed and preliminary r-f tests were in process.
- b. HTS 20-hp drive motors and motor generator system were ordered from Reliance Company.
- c. Information was received from GE Ordnance Department for the design of the NAST 1-kw Diplexer.
- d. Fabrication of the ICM-AGE model was completed.
- e. Fabrication of the 2-watt Doppler reference transmitters was proceeding on schedule at Philco Plant 50.

4. WDL-TR1686 - 20 September 1961 through 20 October 1961

- a. WDL-TR1649, "Project Advent WDL/GE Compatibility Test Plan," WDL-TR1650, "Project Advent TT&C Fly-By Test Plan," and WDL-TR1651, "Project Advent TT&C System Field Test Plan" were released.
- b. Philco WDL agreed with GE that a reconfiguration of the NAST diplexer was desirable.
- c. The design of all receivers was completed. AGE, ICM, and AHM models were delivered.
- d. The data scanner and formatter (DSF) for the GE-AGE (AHM) were delivered to the GE Space Technology Center, and the GE-AGE (VTM) was to be shipped to them on 23 October 1961.
- e. The LMSC A&E drawings for the HTS transmitter building were received and signed off.

5. WDL-TR1716 - 20 October 1961 through 20 November 1961

- a. Fabrication of HTS wave guide bandpass filter was completed.
- b. The scheduled acceptance test date for the Canoga Feed Unit for the HTS installation program was set at 30 November 1961.

- c. The AGE receivers (ICM, AHM and VTM) had been delivered. The HTS model was to be shipped during the week of 20 November 1961.
- d. The HTS console was delivered to Philco WDL for compatibility testing. The Acceptance Test was completed.
- e. The first two telemetry processors scheduled for GE, and the ground timing generator for HTS were completed.
- f. Drawings for the HTS, VHF Building, support area addition were provided to AFSSD.

6. WDL-TR1748 - 20 November 1961 through 20 December 1961

- a. The antenna modification equipment was shipped to HTS with the exception of the dual feed unit and the impedance matcher.
- b. The Fort Dix diplexer acceptance test was completed.
- c. The HTS receiver arrived on site, 8 December 1961. All receiver drawings were released.
- d. The Fort Dix console was shipped on 13 December 1961.
- e. The fourth transmitter, complete with demodulator, was shipped to HTS.
- f. All efforts (Timing and Data subsystem) on the NAST, ICM and ETM models and CRS checkout and site installation were delayed per AFSSD direction.

7. WDL-TR1774 - 20 December 1961 through 20 January 1962

- a. Permission was received by Philco WDL to install the satellite simulator test antenna at FDS.
- b. Philco provided ROM and SCP to AFSSD for the installation of antenna cage equipment at CRS.
- c. A request was initiated to AFSSD and the 6593rd Instrumentation Squadron to install an R-F Radiation Hazard Warning System at HTS.
- d. LMSC was notified of the Philco intention to install a screen room at HTS for the satellite simulator.

8. WDL-TR1800 - 20 January 1962 through 20 February 1962

- a. The CRS console was acceptance tested on 12 February 1962.
- b. The FDS console, on site, was scheduled for acceptance test following installation.
- c. The first dual-Doppler transmitter (and monitor) passed acceptance testing and was delivered to AFMTC.
- d. All Advent equipment was installed at STA except for the line switching unit.
- e. A NAST modification meeting was held at Fort Monmouth, New Jersey, 5 February 1962, to resolve Bendix Systems/Philco WDL interface requirements.
- f. AFMTC equipment arrived on site and Phase I installation was on schedule.

9. WDL-TR1807 - 20 February 1962 through 20 March 1962

- a. The HTS antenna modification was completed and was in process of acceptance test.
- b. The specifications for the NAST diplexer were written and forwarded to AFSSD.
- c. All receivers were completed and delivered to sites.
- d. The r-f assembly for NAST was shipped to GE Ordnance, Pittsfield, Massachusetts, for mounting on the 28-foot antenna superstructure.
- e. All major assemblies had been shipped to CRS and were being mounted in position.

10. WDL-TR1834 - 20 March 1962 through 20 April 1962

- a. Philco WDL sent a consultant and Philco design engineers to HTS to investigate reported troubles in the antenna azimuth drive unit (TLM-18). The visiting team reported that the gears were in good order.
- b. The NAST Master Control Console was in the process of design.

- c. The dual Doppler transmitter for CRS was shipped 2 February 1962.
- d. Drawings for the Doppler transmitter, 1-kw power amplifier, and 20-kw power amplifiers were received from Sierra Electronics.
- e. Bureau of Ships notified Philco WDL that all Shipboard TT&C equipment would be bolted directly to the ship's deck.
- f. 80 percent of Phase III tests were completed at HTS.

11. WDL-TR1842 - 20 April 1962 through 20 May 1962

- a. The final shipment of NAST antenna equipment was shipped to GE Ordnance.
- b. The NAST Master Control Console was in the process of fabrication.
- c. A failure was reported in the HTS 20-kw power amplifier at HTS; the trouble was caused by an open filament in the final amplifier tube. The tube was to be replaced under warranty.
- d. The communications panel for CRS was fabricated and prepared for shipment.
- e. The preliminary system checkout of the Philco WDL-supplied equipment at STA took place during the week of 18 May 1962.

12. WDL-TR1859 - 20 May 1962 through 20 June 1962

- a. In accordance with direction received from AFSSD on 12 June 1962, all work was stopped on the following special studies:
 - Antenna Calibration Study
 - Tracking Improvement Study
 - Low-Noise Study
- b. All NAST subsystem cabinets (OA-69B, OA-97, OA-98, OA-90) were shipped to PNSY.
- c. AGE 3 equipment acceptance tests were scheduled for 25 June 1962.

- d. All tests, and test documentation were completed for the STA equipment. AFSSD was currently reviewing the test data.

13. WDL-TR1868 - 20 June 1962 through 20 July 1962

- a. A noise problem was investigated at HTS and was narrowed to a possible source in the transmission.
- b. The NAST master control console was shipped to PNSY in June 1962.
- c. The NAST digital data terminal equipment was in process of acceptance test.
- d. AGE 2, Phase III acceptance tests at GE-MSVD, were completed 23 June 1962.
- e. The formal Phase III test at FDS was begun 20 June and completed 29 June 1962.

14. WDL-TR1897 - 20 July 1962 through 20 August 1962

- a. The NAST digital data terminal equipment arrived on site 1 August 1962.
- b. Noise was present in the r-f feed system at FDS when either of the 1-kw power amplifiers were coupled to the antenna; this problem was under investigation. Phase IV fly-bys were completed (Series III and IV); Series V was scheduled for 21 August 1962.
- c. The 20-kw power amplifier discrepancies at HTS were eliminated and no further problems were anticipated.
- d. All NAST TT&C equipment was installed aboard ship. Instrument cables were pulled to all equipment. Minor modifications were in process due to differences in wire sizes of WDL specifications and Navy specifications.
- e. The Phase III testing at HTS was completed. Philco WDL was rendering technical support to LMSC on Phase IV tests.

15. WDL-TR1913 - 20 August 1962 through 20 September 1962

- a. Amendment No. 1 (Secret) to Philco WDL-TR1386B, "Design Summary Report Project Advent (U)," was published on 7 September 1962.
- b. Investigation of the problem in the HTS transmission line continued and formal correspondence was sent to Aerospace relating the findings compiled thus far.
- c. The completion of the HTS antenna modification (AT 1772) was expected by 10 September 1962, pending the availability of the antenna and station equipment.
- d. The r-f interference investigation was being conducted by Philco WDL, and was nearly complete. Final demonstration and approval were expected by the end of September.
- e. Philco WDL-TR1901, "Results of Advent TT&C System Acceptance Test," for GE-MSVD (AGE #2) and AFMTC (AGE #3) were generated and published during the week of 20 July 1962.
- f. Phase I and II were completed 14 September 1962 for NAST.

16. WDL-TR1941 - 20 September 1962 through 20 October 1962

- a. Test activities were delayed at FDS pending completion of the Sylvania antenna feed modification.
- b. Phase III testing was completed at HTS 3 October 1962. The R-F feed system noise problem, which was isolated to the "bullet" connectors in the rigid coaxial transmission line, still existed.
- c. Phases I and II were completed on 17 October 1962 at the Camp Roberts Station.
- d. A visit to Philadelphia was made to discuss interface problems and witness performance of the Phase III test at NAST, as related to the Philco WDL equipment.

17. WDL-TR1959 - 20 October 1962 through 20 November 1962

- a. No formal response was received on a request for waiver for the telemetry synchronous threshold requirements.
- b. Publication of the Phase III test report was held up at HTS due to several minor discrepancies discovered during the final editing. The report was expected to be released on or about 15 December 1962.
- c. Two Philco representatives participated in the NAST sea trials, 13 November through 17 November 1962.
- d. DD 250 forms were prepared and were to be sent to the Philadelphia Naval Shipyard in preparation for the buy-off of equipment.
- e. Phase III testing was expected to be completed on 21 November 1962 at CRS. Philco was awaiting AFSSD direction regarding disposition of CRS equipment.

3.2.2 Contractual ChronologyLetter Contract

Philco WDL prepared a Work Statement, WDL-TP326-4, dated 20 February 1961, for the TT&C Subsystem for the Advent Program. The following is a general chronological review of the letter contract AF04(647)-828, May 1, 1961, based upon the referenced Work Statement and changes effected by Amendments and Contract Change Notifications (CCN) thereto:

1. Amendment 1, June 30, 1961 - Incorporated Amendment 1 to WDL-TP326-4, a general revision of work statement.
2. Amendment 2, August 25, 1961 - Increased funding by \$2,235,000 and extended the final date for definitizing the letter contract from July 31, 1961 to December 31, 1961.
3. Amendment 3, September 13, 1961 - Incorporated Amendment 2 to WDL-TP326-4. Added HTS Boresite Tower and associated effort.

4. Amendment 4, October 13, 1961 - Increased funding by \$515,000.
5. Amendment 5, October 20, 1961 - Increased funding by \$1,900.000.
6. Amendment 6, November 28, 1961 - Incorporated Amendment 3 to WDL-TP326-4. Added Exhibit E which set forth STA Network Equipment requirements and added VHF preamplifiers at FDS, CRS and NAST.
7. Amendment 7, not issued - Reserved for termination per Amendment 11.
8. CCN 1, December 12, 1961 - Revised WDL-TP326-4, adding computer programming, AFSSD Exhibit 61-47.
9. Amendment 8, December 29, 1961 - Incorporated Amendment 4 to WDL-TP326-4. Increased funding by \$1,000.000, and extended period of performance from June 30, 1962 to March 1, 1963.
10. CCN 2, January 2, 1962 - Revised WDL-TP326-4 replacing AFBM Exhibit 61-20 with AFSSD Exhibit 61-94.
11. CCN 3, January 15, 1962 - Revised WDL-TP326-4 adding Government Furnished Property.
12. Amendment 9, January 22, 1962 - Increased funding by \$700,000.
13. Amendment 10, February 19, 1962 - Increased funding by \$750,000.
14. CCN 4, March 12, 1962 - Revised WDL-TP326-4 adding GFP.

15. Amendment 12, March 21, 1962 - Increased funding by \$429,000 and extended final date for definitization of letter contract from December 31, 1961 to May 15, 1962.
16. Amendment 13, April 4, 1962 - Increased funding by \$137,500 and incorporated Amendment 5 to WDL-TP326-4. Extended period of performance from March 1, 1963 to March 21, 1963 and extended final date for definitization of letter contract from May 15, 1962 to September 15, 1962.
17. Amendment 11, June 1, 1962 - Definitized funds of \$1,000,000 into AF04(695)-112.
18. Amendment 14, June 11, 1962 - Recognition of the Novation Agreement reflecting acquisition of the Philco Corporation by the Ford Company.

Definitive Contract

The Definitive Contract AF04(695)-112, February 15, 1962 superseded the Letter Contract AF04(647)-828, May 1, 1961, Amendments 1 through 5 thereto, Amendment 8 thereto (pertaining to funding), Amendment 9 thereto, CCN's 1, 2 and 3 thereto, and Amendments 15 and 20 to Letter Contract AF04(647)-532, January 8, 1960. The following is a general chronological review of the Definitive Contract and changes effected by change orders (CO), Contract Change Notifications (CCN) and Supplement Agreements (SA):

1. CO 1, April 20, 1962 - Increased funding by \$250,000 and extended period of performance covered by funds to May 31, 1962.
2. CCN 1, May 11, 1962 - Revised AFSSD Exhibit 61-7. Added GFP to FDS, CRS and HTS.

3. SA 2, May 22, 1962 - Definitized Amendment 6 to letter contract.
4. SA 3, June 11, 1962 - Definitized Amendment 13 to letter contract (funding only) and Amendment 10 to letter contract.
5. CCN 2, June 11, 1962 - Revised AFSSD Exhibit 61-7. Added GFP to FDS and CRS.
6. CO 5, June 25, 1962 - Increased funding by \$330,000. Period of performance covered by funds extended to July 7, 1962.
7. CCN 3, June 27, 1962 - Revised AFSSD Exhibit 61-7. Added GFP to FDS, CRS and HTS.
8. CO 6, June 28, 1962 - Increased funding by \$410,000. Period of performance covered by funds extended to August 5, 1962.
9. SA 7, August 23, 1962 - Added Patent Right Clause.
10. SA 4, August 27, 1962 - Incorporated Amendment 3, May 17, 1962 to AFSSD Exhibit 61-7 by reference.
11. CO 8, not issued.
12. CO 9, October 30, 1962 - Increased funding by \$9,000 and increased estimated cost by \$291,000.
13. SA 10, December 1962 - Superseded Amendments 8, 11, 12, 13, CCN 4 to letter contract AFO4(647)-828 and thereby completely superseded said letter contract.

Financial Record

A general chronological review of the financial activities is contained in a memorandum Advent Financial History, January 8, 1963 to J. K. Campbell, located in the Advent Archives..

3.2.3 Installation and Checkout Chronology

Philco had major responsibilities for I&C effort in accordance with Paragraph 1.7 of AFSSD Exhibit 61-7, Amendment 2, dated April 1962, for the following areas:

1. Philco WDL Compatibility Checkout; Palo Alto, California.
2. Aerospace Ground Equipment; GE/MSVD, Valley Forge, Pennsylvania and AFMTC, Cape Canaveral Florida.
3. Satellite Test Annex; Sunnyvale, California
4. Hawaiian Tracking Station; Kaena Point, Oahu, Hawaii.
5. Fort Dix Station; Lakehurst, New Jersey.
6. Camp Roberts Station; Paso Robles, California.
7. Navy Advent Shipboard Terminal; Philadelphia Navy Shipyard; Philadelphia, Pennsylvania.

Philco WDL Compatibility Checkout

Responsibility. Philco WDL was responsible for installation and checkout at the Palo Alto plant of those portions of the TT&C ground equipment and airborne equipment to insure compatibility. Tests were conducted in accordance with "Project Advent WDL-GE Compatibility Test Plan," WDL-TR1649, Amendment 1, (Secret).

Phase Completion. Installation of equipment began on 5 October 1961 and was completed on 1 November 1961. Compatibility tests were conducted from 1 November 1961 to 6 December 1961. Tests were conducted from 6 December 1961 to 21 December 1961 to assist General Electric in development of the Satellite equipment. The final compatibility tests were conducted from 12 February 1962 to 22 February 1962.

Results. The objective of the compatibility tests was to perform the necessary tests to insure the technical compatibility of the equipment comprising the ground TT&C subsystem and the airborne TT&C subsystem. As a result of these tests, incompatibilities were disclosed and sufficient data obtained to accomplish necessary design revisions. A secondary objective of these tests was to perform marginal checks to provide an index of system capability under conditions of degradation. The results of the tests were reported in "Project Advent, History and Results of WDL-GE TT&C Compatibility Tests," WDL-TR1740, dated March 31, 1962 (Secret).

Aerospace Ground Equipment, GE/MSVD, and AFMTC

Responsibility. Philco WDL was responsible for:

1. Phase I - Installation of the equipment racks and connection of the inter-rack cabling and equipment cable terminations in accordance with documented interface agreements with General Electric.
2. Phase II - Verification of proper installation of individual equipment and correct terminations of inter- and intra-cabinet wiring and "smoke tests."
3. Phase III - The checkout of individual equipment and of the overall AGE TT&C subsystem to assure its operational capability. Tests procedures were to be conducted in accordance with "Project Advent TT&C System Acceptance Tests, GE/MSVD and AFMTC," WDL-TR1773, Amendment 2, 18 June 1962.
4. Operation and Maintenance - Support the Air Force and GE in the operation and maintenance of the TT&C equipment and provide engineering services and coordinate changes and modifications to the specified equipment initiated as a result of program development. This support to be provided both at GE/MSVD and AFMTC.

Phase Completion. For the first delivered AGE set to GE/MSVD: Phases I & II began on 24 October 1961 and were completed 17 November 1961; O&M began on 17 November 1961 and ended on 21 December 1962; Phase III began on 1 June 1962 and was completed 23 June 1962. For the second delivered AGE set to GE/MSVD: Phases I & II began on 12 December 1961 and were completed 19 December 1961; O&M began on 19 December 1961 and ended 7 December 1962; Phase III began on 1 June 1962 and was completed 23 June 1962. For the third delivered AGE set to AFMTC: Phases I & II began on 12 February 1962 and were completed 23 February 1962; O&M began on 23 February 1962 and ended 9 November 1962; Phase III began 24 June 1962 and was completed 1 July 1962.

For the fourth and fifth AGE sets to be delivered, the delivery of these units was cancelled in accordance with SG 032, 27 July 1962; they were sold to the Air Force on 20 November 1962.

Results. A static system acceptance test was performed on AGE #2 and AGE #3. The tests were conducted without the use of the Satellite Simulator. A crystal mixer was utilized as an "up-converter" or translator to close the r-f loop between the AGE transmitter and receiver. The test results are contained in "Results of Advent TT&C System Acceptance Tests, GE/MSVD and AFMTC," WDL-TR1901, 21 September 1962.

Problems. The prime interface, basic system designs and concepts, was not a major problem in that the vehicle-ground systems were basically compatible with only minor changes in signal levels, timing, etc. The major technical difficulty, which had been anticipated by both contractors, was the problem of r-f interference between simulators and the ground stations; between AGE units and vehicle equipment. The cause of the problem was that both simulator and AGE transmitters had only to meet the standard MIL specification on radiation, yet the ground and vehicle TT&C receivers were of high sensitivity. With full attenuation, receivers would lock-on to transmitters so that minimum signal level testing could only be performed if additional isolation was provided by separation or by use of screen rooms.

Satellite Test Annex

Responsibility. Philco WDL was responsible for:

1. Phase I - Installation of the equipment racks and connection to power facilities only.
2. Phase II - Checkout of individual equipment with assistance from LMSC.
3. Phase III - Not required; however, particular tests to prove equipment functions were accomplished.

Phase Completion. Phase I and II began on 1 February 1962 and were completed on 16 February 1962. Modified Phase III began on 14 May, 1962 and was completed 1 June 1962.

Results. The operation of the individual equipment was demonstrated to AFSSD and Aerospace. All equipment performed correctly with exception of the printers. The printers checked out properly under static tests, but could not be completely tested dynamically because of STC interface difficulty. The test results are contained in a report on Results of Demonstration Tests of Philco Advent Equipment supplied to STA, 24 May 1962.

Hawaiian Tracking Station

Responsibility. Philco WDL was responsible for:

1. Phase I - Installation of the Advent equipment, inter-rack cabling and facilities support equipment, including the modification of the TLM-18 antenna r-f feed system, servo and drive system, except for the slip-ring assembly.

2. Phase II - Verification of proper installation of individual equipment and correct termination of inter- and intra-cabinet wiring and "smoke tests."
3. Phase III - Checkout of the TT&C ground system to demonstrate performance in accordance with the prime equipment specification. The static test procedures were conducted in accordance with "Project Advent TT&C System Acceptance Test Plan," WDL-TR1651A. The dynamic test procedures for Phase A and B fly-by were conducted in accordance with "Project Advent TT&C Fly-by Test Plan," WDL-TR1650.
4. Phase IV - Assist LMSC in station system testing.

Phase Completion. Phases I and II began October 16, 1961 and were completed March 3, 1962. Phase III began April 10, 1962 and was completed on July 17, 1962. Phase IV began July 25, 1962 and was completed October 3, 1962.

Results. Both static and dynamic system acceptance tests were performed. The static tests consisted of functional subsystem and system tests utilizing the GE-supplied satellite simulator in conjunction with the ground TT&C system. Electronic interference tests were conducted to assure radio frequency interference free operation for the tracking station. The test procedures are contained in "Project Advent Electronic Interference Test Plan," WDL-TR1752. The dynamic tests consisted of two fly-by tests, Phase A and Phase B. Phase A consisted of dynamic antenna accuracy tests utilizing an airborne radio beacon. Phase B consisted of an operational program test utilizing an airborne satellite simulator. The results of the tests were reported in "Results of Advent TT&C System Acceptance Tests, HTS," WDL-TR1915, dated December 28, 1962.

Problems. The interface for TT&C subsystem was difficult in that HTS was an active operational station, supporting other programs. As such, the equipment configuration of the TT&C subsystem, and the equipment being interfaced with it, were different. Overshadowing the technical interface problems was the scheduling interface. Much of the Advent TT&C effort at Hawaii had to be sandwiched into "windows", the short periods during which the station had no support commitments to other programs. In practically all instances, the operational commitments had priority with the further requirement that the station be operational for the support mission at the conclusion of the "window". This entailed back tracking of work if required by operation schedule shift or if difficulties in installation and checkout were encountered.

The major technical interface was in the area of the antenna modification, which was also the most critical item on station for operational support. The modification was divided into two areas: the prime modification performed by Philco WDL, and the change of the slip ring assembly being performed by LMSC. The installation interface was also quite extensive as some new facilities were required, some existing facilities were utilized, and all active interfaces occurred with operating equipment.

Trouble in the HTS R-F Transmission subsystem was experienced since initial operation of the station. The problem was excessive noise on the input terminals to the paramps when vibration was present in and around the transmission line.

Investigation of the problem by Philco WDL microwave personnel led to the theory that rigid coax connectors inside the transmission line joints are causing the noise bursts as they slide back and forth with contractions and expansions of the waveguide. These noise bursts are present only when transmitting into the waveguide, further proving the theory of thermal expansion and contraction. A study was initiated at Philco WDL with a resulting report, "Transmission Line Noise, Advent Program," dated December 30, 1962 by R. M. Wert; this report is contained in the archives.

During the course of station checkout and system sell-off at HTS, a failure occurred in the 20-kw power amplifier. This failure, open filaments in the Eimac Klystron, was originally believed to be a normal-within-warranty-type early failure due to a defective part in the tube. Later failure of a second tube in the same mode, with subsequent laboratory investigation indicated that trouble existed in the system. An intensive investigation was launched on the probable cause of failure, resulting in a slight change in the power amplifier tuning procedure to prevent overcoupling. The problem was pinpointed to general misunderstanding of the loading characteristic of this specific type of klystron tube by the amplifier subcontractor and by Philco WDL. The problem was resolved with no further failures occurring.

Fort Dix Station

Responsibility. Philco was responsible for:

1. Phase I - Installation of the equipment racks in the Advent equipment bay and in the antenna cage. Provide inter-rack cabling and equipment cable terminations in accordance with existing documented interface agreements with Sylvania.
2. Phase II - Verification of proper installation of individual equipment and correct termination of inter- and intra-cabinet wiring and "smoke tests".
3. Phase III - Checkout of the TT&C ground system after integration with the Sylvania antenna. The static test procedures were conducted in accordance with "Project Advent TT&C System Acceptance Test Plan," WDL-TR1651A. The TT&C system dynamic tests were conducted in accordance with WDL-TR1651A and USASRD1 Advent Ground Station Integrated Fly-By Test Program, June 1, 1962.

Phase Completion. Phases I and II began November 15, 1961 and were completed March 2, 1962. Phase III began June 6, 1962 and was completed July 15, 1962. Phase IV began July 10, 1962 and was considered complete August 27, 1962 because of the Sylvania conical scan problem being unresolved.

Results. Static and dynamic system acceptance tests were performed. The static tests consisted of functional subsystem and system tests utilizing the ground based GE satellite simulator in conjunction with the ground TT&C system. Some modifications were made in the subsystem test procedures during testing to coincide with updated system specifications and operational necessities. The revisions were coordinated with AFSSD and Aerospace. The final test results are contained in "Results of Advent TT&C System Acceptance Tests, FDS," WDL-TR1982, dated December 31, 1962. A typical TT&C installation is shown in Fig. 3-3 for the Fort Dix Station.

Problems. A major technical interface problem, occurred in August 1961 with the VHF receiver preamplifiers. The original concept provided a VHF hard tube preamplifier, with input to the TT&C receiver and to a tracking receiver. The interface with the facility contractor was at the output of the preamplifier and the input to the TT&C receiver mixer. Philco's analysis of this configuration disclosed that the down link would be, at best, marginal. Philco proposed, with Aerospace concurrence, that the VHF preamplifier be changed to a parametric of the type being utilized by the TT&C system at HTS, moving the interface to the output of the sum hybrid, and eliminating the hard tube preamps. This change involved other cabling and interface changes as well. The change was later approved.

Due the unavailability of slip rings, the TT&C VHF receiver replaced the previous receiver for tracking input to the antenna system. Later in the program, the re-routing of slip ring cabling and tracking inputs by the facility contractor caused delays in TT&C receiver subsystem checkout.

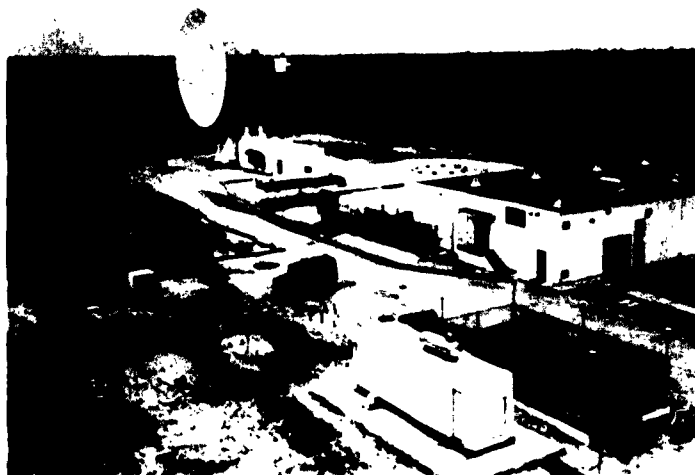


Fig. 3-3a Fort Dix Station

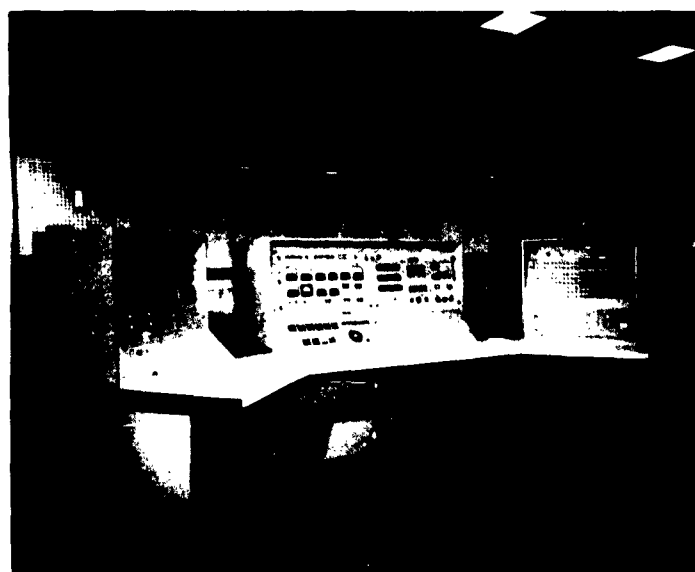


Fig. 3-3b FDS TT&C Master Control Console



Fig. 3-3c FDS TT&C Equipment (L to R) Computer Digital Recorders and Receiver/Transmitting Subsystem Racks and Satellite Simulator.



Fig. 3-3d FDS TT&C Equipment (L to R) Tracking Doppler Processor, Telemetry Processor, Switching, Redundant Tracking Doppler and Telemetry Processor Racks, Timing Generator, Digital Data Terminal and Command Processor Distributor Racks.

The last problem became apparent during checkout at Fort Dix. The checkout and acceptance of the antenna by the facility contractor was to precede the TT&C subsystem checkouts, Phase III and IV. The accomplishment of Phase III was continually delayed due to non-availability of the antenna. An overly optimistic antenna checkout schedule and, later, major technical problems encountered with the feed system were the prime factors in delay of TT&C subsystem checkout.

Camp Roberts Station

Responsibility. Philco WDL was responsible for Phases I, II and III as previously outlined for FDS except that WDL-TR1651A was amended for Phase III.

Phase Completion. A modified Phase I, (equipment mounted in place only) began on March 20, 1962 and was completed on March 23, 1962. Phase I cabling and Phase II began in August 15, 1962 and were completed on October 17, 1962. Phase III began October 20, 1962 and was completed on November 20, 1962. Phase IV was cancelled in accordance with SG033, 27 July 1962.

Results. Static system acceptance tests only were performed. The final test results are contained in "Results of Advent TT&C System Acceptance Tests, CRS," WDL-TR1985, dated December 31, 1962.

Navy Advent Shipboard Terminal

Responsibility. Philco was responsible for:

1. Phase I - Monitor and provide technical assistance to the Philadelphia Naval Shipyard for all aspects of the TT&C equipment installation. Installation in accordance with Philco WDL specification Installation Services, NAST, 98-2154-02, Amendment 1.

2. Phase II - Review results of the cabling checkout and assist PNSY by activating power switches on all TT&C equipment.
3. Phase III - Checkout the TT&C system after integration with the GE antenna. The static test procedures were conducted in accordance with "Project Advent TT&C System Acceptance Test Plan," WDL-TR1651A and the NAST Supplement to that document, dated July 6, 1962.
4. Phase IV - Assist Bendix Systems in performing the overall station compatibility tests.

Phase Completion. Phases I and II began July 23, 1962 and were completed September 12, 1962. Phase III began September 13, 1962 and was completed October 13, 1962. Phase IV was cancelled in accordance with SG033, July 27, 1962.

Results. Static system acceptance tests were performed, and the results are contained in "Results of Advent TT&C System Acceptance Tests, NAST," WDL-TR1958, dated December 28, 1962.

Problems. The NAST station contributed the most complex management interface within a program which basically operated under a complex management structure. The prime NAST interface problem areas occurred in defining the NAST effort and in obtaining updated direction from the different contracting agencies to their respective contractors; e.g., Philco WDL received "stop effort" direction from AFSSD on the TT&C subsystem during a period when the NAST integrating and NAST associate contractors could obtain no schedule relief from BUSHIPS. Problems of this nature overshadowed the large number of technical interface problems involved in a different TT&C configuration, a different antenna and tracking data subsystem, and the different installation environment.

The first attempt to provide an integrated schedule for equipment delivery, installation, and checkout in which all contractors participated occurred less than two months prior to start of actual equipment installation.

The documentation provided for the installation changed format and, in the case of cabling and wire lists, changed designations at the Liaison Contractor level, the Integrating Contractor level, and, again at the Navy Engineering level.

3.3 DOCUMENTATION¹

3.3.1 Specifications

In accordance with Section 5 of AFSSD Exhibit 61-7, Amendment No. 2, dated 13 April 1962, a separate specification was written for each significantly different equipment subsystem, which required specification approval as a developmental item. Specifications were organized to the format contained in MIL-S-6644A and specifically adhered to the requirements outlined in AFSSD Exhibit 61-7 as to performance, acceptance tests, and detail information.

The Advent Program Specifications Tree, dated 31 August 1962, serves as an index for specifications of all types initiated by the Advent Program to support the TT&C subsystem and includes information concerning:

1. Military Specifications
2. Reliability Criteria and Test Procedures
3. Subsystem Descriptions
4. Procurement Specifications

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1. A list of the documents stored in the Philco WDL Archives is contained in Appendix A of this report.

5. Subsystem Acceptance Test Specifications

6. Installation Services Specifications

A complete file of all specifications referenced has been retained in the Philco WDL Project Specifications Department.

3.3.2 Engineering Equipment List

The Advent Program Engineering Equipment List, Revision E, dated 12 April 1962, was prepared as a working tool and was used as a cross reference to equipment items listed in AFSSD Exhibit 61-7, Section 6. In this document, the equipment is listed first by site, second by the major subsystem at that site, third, by the major equipment and/or cabinets within the major subsystem, and then the panel assemblies within the major equipment and/or cabinets are listed. Further, the Equipment List contents are coded and formatted to show:

1. Major subsystem at a site.
2. Operating assembly number within the major subsystem.
3. Panel assembly
4. Vertical dimensions of panels.
5. WDL Model number of equipment.
6. Standard noun description of equipment.
7. Vendors code.
8. Assembly drawing number including configuration.
9. WDL specification number.

This list was used as the basis for the Table and Inventory List of TT&C Equipment for the various sites. (Refer to Paragraph 3.3.4 of this report.)

3.3.3 Drawings

Drawings or reproducibles, as specified in Section 5.2 of AFSSD Exhibit 61-7, Amendment 4, dated 5 November 1962, have been provided to AFSSD and Aerospace Corporation, as required.

In the interests of economy and standardization, the Advent Program Office initiated a project to microfilm all drawings pertaining to Advent TT&C equipment, facilities and installations. Due to this effort, all Advent drawings, with the exception of some vendor specification control drawings, were provided to the ground stations. Specifically a set of microfilm aperture cards, a microfilm viewer, and two sets of "B" size prints were furnished to the following sites:

1. Fort Dix Station, 1754 cards
2. Camp Roberts Station, 1754 cards
3. Navy Advent Shipboard Terminal, 1625 cards
4. Philco WDL (archives), 3220 cards

In accordance with Paragraph 5.2.2 of AFSSD Exhibit 61-7, 3220 "B" size reproducible vellums, which were made as a part of the microfilm effort, were provided to AFSSD.

While the Advent Drawing Index indicates that approximately 4,500 drawings are necessary for each site, elimination of duplicate drawings resulted in a reduced number of cards required for the indicated sites.

3.3.4 Reports

Philco WDL Technical Reports and Preliminary Information Reports (PIR's) were prepared in accordance with Paragraph 1.4 of AFSSD Exhibit 61-7, to document the Advent Program effort and provide preliminary technical information.

Technical Reports

WDL technical reports are numbered in serial order of receipt, from number 1000, by the Technical Publications Section. Revisions of previously issued documents can be identified by an alphabetic notation after the report number; e.g., WDL-TR1584A. Authors names are usually not included on Philco WDL reports because most documents represent group efforts.

The bibliography of all Advent Technical Reports published from September 1960, except this report, are contained in the following Philco WDL Technical Reports, which are available from the Technical Publications Section:

1. WDL-TR1783, Revision 1, April 30, 1962
2. WDL-TR1783, Revision 1, Addendum 1, July 31, 1962
3. WDL-TR1783, Revision 1, Addendum 2, October 31, 1962
4. WDL-TR1783, Revision 1, Addendum 3, December 31, 1962

In these documents the reports are grouped by the applicable section and paragraph of AFBM Exhibit 58-1, under which they were submitted.

Preliminary Information Reports (PIR's)

Early in the Advent Program an interim requirement was recognized to communicate to all program personnel information not supplied by memos or regular WDL Technical Reports. The Preliminary Information Report (PIR) was developed to fill the requirement for both documenting and disseminating information. In the following bibliography, of the twenty-two PIR's produced, it will be noted that PIR's number 3, 4, 8, 9 and 10 are classified "Secret" and the Philco WDL Master Document Control number is indicated. The balance of the PIR's are located in the Philco archives.

1. PIR #1, 24 July 1961, "Space/Ground Telemetry Link Calculations, Final Stage Vehicle, Kaena Point," by G. R. Hickcox.
2. PIR #2, 7 August 1961, "TT&C Ground Station, Advent, Reliability Preliminary Estimates," by R. M. Wert.
3. PIR #3, 9 August 1961, "Space/Ground Link Calculation, FSV and OTV, Acquisition, Tracking and Telemetry; Kaena Point, Fort Dix and Camp Roberts," by G. R. Hickcox, Secret, A019226.
4. PIR #4, 14 August 1961, "Ground/Space Link Calculation, FSV, Stabilized and Tumbling, Kaena Point and Fort Dix/Camp Roberts," by G. R. Hickcox, Secret, A018779.
5. PIR #5, 17 August 1961, "S/N Analysis of Revised Camp Roberts/Fort Dix R-F System Based on Dual Channel Noise Contribution and Non-Lossy Track Summing Hybrid," by G. R. Hickcox.
6. PIR #6, 23 August 1961, "Probability Study to Determine the Feasibility of Eliminating the Random Bit Command Comparison in Command Processor," by K. Oshima.

7. PIR #7, 29 August 1961, "Frequency Spectrum and Noise Power at Output of Command Transmitter," by K. Oshima.
8. PIR #8, 20 September 1961, "Comparison of Integrate-and-Discharge Filter with Present Receiver Subsystem," by K. Oshima, Secret, A018556.
9. PIR #9, 10 October 1961, "Space/Ground and Ground/Space Acquisition, Tracking and Telemetry Link Calculations, Final Stage Vehicle, NAST," by G. R. Hickcox, Secret A019377.
10. PIR #10, 12 October 1961, "Effect of Receiver Sweep Rate in Mode 2 (AJ Mode) on System Performance," by K. Oshima, Secret, A019378.
11. PIR #11, 20 October 1961, "Operational Description of R-F Equipment," by T. Connor.
12. PIR #12, 14 November 1961, "Maximum Antenna Sweep Rate at Fort Dix/Camp Roberts," by G. R. Hickcox.
13. PIR #13, 8 December 1961, "Effect of Incidental Phase Modulation on Ground Receiver Performance," by K. Oshima.
14. PIR #14, 14 December 1961, "Ground Station Vehicle Acquisition," by G. R. Hickcox.
15. PIR #15, 18 December 1961, "Storage of Advent Equipment in the Bonded Warehouse, Building 58U," by R. M. Wert.
16. PIR #16, 22 January 1962, "Supplement to PIR #13; Demodulation in the Presence of Residual Phase Modulation," by K. Oshima.

17. PIR #17, 12 January 1962, "Philco Supplied Equipment for the STC," by J. Bean.
18. PIR #18, 31 January 1962, "Advent TT&C, Radiation, Acquisition, Telemetry, and Doppler Portions of the WDL/GE Compatibility Test," by E. D. Cotterel.
19. PIR #19, 31 January 1962, "Antenna Boresighting by Means of Satellites," by W. Widener.
20. PIR #20, 9 February 1962, "Advent TT&C Equipment Temperature Survey," by G. Johnson.
21. PIR #21, 15 March 1962, "Range Measurement from Transit Time of Data Transmission," by N. Tom and P. Crill.
22. PIR #22, 27 March 1962, "Comparison of Demodulated Sub-carrier Waveforms with Post-Detection Filtering in the Ground Receivers," by K. Oshima.

3.3.5 Technical Manuals

In accordance with Paragraph 1.5.4 of AFSSD Exhibit 61-7, equipment and system oriented technical instruction was provided in the form of class III Technical Manuals.

All of the listed Technical Manuals were delivered to the indicated sites. Copies of the manuals are located in the Philco WDL Technical Manuals Section.

1. Technical Manuals delivered to Fort Dix, Camp Roberts, Hawaiian Tracking Station, Navy Advent Shipboard Terminal, and General Electric sites:
 - a. WDL-TM-AV-3002-3, UHF Doppler, Telemetry and Angle-Tracking Receiver; Field Maintenance.

- b. WDL-TM-AV-3009-3, One-Kilowatt Diplexer-Filter; Field Maintenance.
 - c. WDL-TM-AV-3012-3, Telemetry Processor; Field Maintenance.
 - d. WDL-TM-AV-3013-3, Tracking Doppler Processor; Field Maintenance.
 - e. WDL-TM-AV-3014-3, Digital Data Terminal Equipment, Field Maintenance.
 - f. WDL-TM-AV-3015-3, Command Processor Distributor; Field Maintenance.
 - g. WDL-TM-AV-3016-3, Ground Timing Generator; Field Maintenance.
 - h. WDL-TM-AV-3017-3, Transmitter Alignment Equipment; Operation and Service (2 Vols.)
 - i. WDL-TM-AV-3018-3, Receiver Analog Tape Recorder; Operation and Service.
 - j. WDL-TM-AV-3019-3, Receiver Test and Monitor Equipment; Operation and Service (3 Vols.)
 - k. WDL-TM-AV-3020-3, Chassis Card Tester; Operation and Service.
 - l. WDL-TM-AV-3021-3, Switching Unit Assembly; Field Maintenance.
2. Technical Manuals delivered to Fort Dix and Camp Roberts sites only:
- a. WDL-TM-AV-3003-3, UHF Doppler Reference Transmitting Subsystem; Field Maintenance.
 - b. WDL-TM-AV-3026-4, (Preliminary copy only), TT&C System Primary Station; Operation and Checkout.
 - c. WDL-TM-AV-3031-3, Master Control Console, WDL-OA-154; Field Maintenance.

3. Technical Manuals delivered to Hawaiian Tracking Station only:

- a. WDL-TM-AV-3001-3, UHF Data-Track Antenna and Control Equipment; Field Maintenance.
- b. WDL-TM-AV-3010-3, Master Control Console WDL-OA-62; Field Maintenance.
- c. WDL-TM-AV-3011-3, Remote Time Display Unit; Field Maintenance.
- d. WDL-TM-AV-3024-3, Antenna Boresight Equipment; Operation and Service.
- e. WDL-TM-AV-3027-4, (Preliminary copy only), TT&C System Secondary Station; Operation and Checkout.
- f. WDL-TM-AV-3029-3, UHF Doppler Reference Transmitting Subsystem; Field Maintenance.

4. Technical Manuals delivered to Navy Advent Shipboard Terminal only:

- a. WDL-TM-AV-3028-4, (Preliminary copy only), TT&C System NAST; Operation and Checkout.
- b. WDL-TM-AV-3030-3, UHF Doppler Reference Transmitting Subsystem; Field Maintenance.
- c. WDL-TM-AV-3039-3, Digital Data Relay Equipment; Field Maintenance.
- d. WDL-TM-AV-3040-3, Digital Data Terminal Equipment; Field Maintenance.
- e. WDL-TM-AV-3041-3, Master Control Console WDL-OA-230; Field Maintenance.
- f. WDL-TM-AV-3042-3, Tracking - Doppler Processor WDL-OA-190; Field Maintenance.

5. Technical Manuals delivered to all GE sites at King of Prussia, Pennsylvania and AFMTC Cape Canaveral, Florida only:

- a. WDL-TM-AV-3008-3, Five-Watt Diplexer-Filter; Field Maintenance.
- b. WDL-TM-AV-3022-3, Test Sequence Programmer Adapter; Field Maintenance.

6. Technical Manuals to Satellite Test Center only:

- a. WDL-TM-AV-3032-3, Digital Data Terminal Equipment; Field Maintenance.
- b. WDL-TM-AV-3034-3, Stylus Recorder Console; Operation and Service.
- c. WDL-TM-AV-3035-3, Digital Recorder Console; Operation Service.
- d. WDL-TM-AV-3036-3, Control Display Console; Field Maintenance.
- e. WDL-TM-AV-3037-3, Line Switching Assembly; Field Maintenance.
- f. WDL-TM-AV-3038-3, Command Network Control Unit; Field Maintenance.

The requirements for Technical Manuals 3004, 3005, 3006, 3007, 3023, 3025 and 3033 were planned, but cancelled so that these numbers do not appear.

3.3.6 Film Reports

Photographic coverage of the Advent Program activities was provided in accordance with Paragraph IV C and D of the AFSC Photographic Exhibit, using AFBMD Exhibit 58-1 as a guide. All milestone activities were thoroughly documented on film with coverage including both moving picture footage and still photographs of all tracking station.

In addition, Philco WDL has on file two hundred and two, 35mm slides of Advent activities, which were not contractually required or delivered. Ninety-six black and white negatives and color transparencies were delivered to AFSSD with copies available from the Philco WDL

Photo Laboratory. Copies of all of the 35mm slides, and all of the black and white pictures and color transparencies are also located in the files of the Technical Publications and Presentations Department of Philco WDL.

The motion picture film listed below was provided to AFSSD and is also indexed and on file at Film for Industry, Menlo Park, California.

1. Fort Dix Station - Film numbers WDL P-020 and P-025.
2. Camp Roberts Station - Film number P-022.
3. Hawaiian Tracking Station - Taken by Air Force Personnel under WDL direction, no identifying number.
4. Navy Advent Shipboard Terminal - Taken by Navy personnel, no identifying number.
5. Philco WDL, Fabrication, Test and Training - Film numbers P-012, P-013, P-015 and P-018.
6. Philco WDL Packing and Shipping - Film number P-018.

3.4 SUPPORT

Various support activities where necessary in order to accomplish the requirements of AFSSD Exhibit 61-7. Although briefly reported, herein, the time and effort expended in these activities greatly contributed to completion of the Advent TT&C Program.

3.4.1 Reliability

The reliability program was initiated in accordance with Paragraph 4 of AFSSD Exhibit 61-7. Early in the Advent Program the reliability effort provided studies to show the redundancy requirement

for certain TT&C equipment. As a result of these studies and negotiations, sufficient redundancy was provided to insure specified MTBF rates. The reliability effort also produced the following letter reports which are filed in the archives:

1. CRS - FDS System Reliability Model
Refer to 16-611-2-2-390, October 25, 1962
2. FDS Reliability Terminal Report
Refer to 16-661-2-398, November 12, 1962
3. CRS Reliability Terminal Report
Refer to 16-661-2-2-404, December 6, 1962
4. NAST Systems Reliability Model
Refer to 16-661-2-2-390, October 3, 1962
5. NAST Reliability Terminal Report
Refer to 16-661-2-2-402, December 4, 1962
6. HTS Systems Reliability Report
Refer to 16-661-2-2-294, July 10, 1962

On October 19, 1962 redirection was received from AFSSD which severely restricted further reliability effort except for the maintenance of appropriate logs to prepare MTBF reports during I&C and to identify and report major modifications that would be required as a result of such MTBF reports.

3.4.2 Minor Modifications

The Advent minor modifications effort was established in December 1961. The purpose of this effort was to receive and coordinate all proposed modifications in order to insure technical feasibility, cost to implement, engineering and design effort, documentation changes, and

site completions. Minor Modifications were those changes required to improve or correct existing equipment operation, or to modify existing equipment to meet requirements not originally designed therein. The cost limit of \$10,000 on any one minor modification was established by Air Force direction.

A total of forty-four proposed modifications were submitted from both the site personnel and engineers at Philco WDL. Of this total, twelve were cancelled, thirty-two were completed in-house as to the necessary documentation changes and installation instructions and parts kits and sent to the applicable sites. Of the thirty-two modifications completed in-house and sent to applicable sites, twenty-four were completed at all applicable sites and of the remaining eight, some are completed but not at all applicable sites. The status of all modifications is contained in the archives.

3.4.3 Training

Formal technical training was provided in accordance with Paragraph 1.5.2 of AFSSD Exhibit 67-1. Five sessions of courses, starting in September 1961 and extending until September 1962, were provided to a total of one hundred and eleven students as follows:

1. General Electric - 5 Students
2. Aerospace - 2 Students
3. U. S. Air Force - 21 Students
4. U. S. Army - 16 Students
5. U. S. Navy - 15 Students
6. LMSC - 17 Students
7. Philco - 35 Students

3-43

Each session consisted of approximately four weeks of intensive lectures utilizing job sheets, work sheets, manuscripts, work assignments and other training aids. The training material used with the Navy Personnel was prepared and assembled in books of 550 pages for each student in accordance with BUSHIPS training specifications.

Copies of all training materials used are located in the Philco WDL Training Department.

3.4.4 Personnel Planning

In accordance with Paragraph 1.5.3 of AFSSD Exhibit 61-7, personnel planning information was submitted for the Fort Dix Station. This information is contained in WDL-TR1843, located in the archives, and covers personnel requirements for management, operations/maintenance and technical support of the TT&C system at the Fort Dix Station.

Also, included are inputs from the 6594th Aerospace Test Wing for the Air Force on-site Commander and Staff. Further, subsystem's planning efforts were curtailed by redirection from AFSSD in July 1962, so that further personnel subsystem planning documents were not produced.

3.4.5 Studies

In accordance with Paragraph 9, of Work Statement WDL-TP326-4, dated 25 August 1961, (revised), a design study program was conducted. Early in the program, the Automatic Station Checkout Study was cancelled by AFSSD. In addition, AFSSD cancelled the following studies in June, 1962:

1. Low Noise Receiving System
2. Tracking Improvement
3. Antenna Calibration

The following studies were completed and are located in the Philco WDL Publication Department and the Advent archives:

1. Command System Improvement, WDL-TR1891, 13 August 1962.
2. Anti-Jamming Techniques Improvement, WDL-TR1869, 1 August 1962.
3. Telemetry Reception Improvement, WDL-TR1909, 1 October 1962.
4. FSD/PM Threshold Determination, WDL-TR1870, 15 August 1962.

3.4.6 Logistics

The logistics support was provided for the Advent Program in accordance with Paragraph 1.8 and Section 3 of AFSSD Exhibit 61-7 as amended.

Documentation

Tables of Equipment and Inventory List, which include all prime and support test equipment, were completed in January 1963, for all Advent sites.

Indentured Data Lists, which is a logistics working tool and consists of all Advent drawings, were completed in January 1963 for all Advent sites. Spare Parts Lists for all sites were completed in January 1963.

Spares

Provisioning action was severely hampered by the several instances of schedule and contract changes. As a result, complete provisioning was not accomplished for any of the Advent sites, although the amount of spares actually provided to the sites from the incomplete provisioning lists was high under the conditions of numerous redirection.

Nearly all required spares were delivered to the NAST Ship with the remaining sites receiving between 25 percent to 50 percent of the required spares. The actual status of all Logistics support is described in a letter, dated 9 January 1963 to A. G. Rhodes from Manager, Logistics Department, Subject: Logistic Advent Program Progress Report as of 31 December 1962; this letter is located in the archives.

3.4.7 Security

Throughout the program, Advent security was conducted in accordance with the "Industrial Security Manual for Safeguarding Classified Information," which is an attachment to DD Form 441, "Department of Defense Security Agreement" and the applicable Security Checklist, DD Form 254.

In concluding the program, a memo was distributed throughout Philco WDL on 20 December 1962 requesting that all personnel possessing classified documents either obtained or generated for the Advent Program comply with the "Industrial Security Manual," which requires that all classified documents utilized for a program be disposed of in one of the following ways: 1) destroy, 2) return to originating source, or 3) apply to contracting office (AFSSD for Advent) for permission to retain for use on other programs.

In addition, all Visit Clearance Requests connected with the Advent Program were terminated.

SECTION 4

COMPLETION

4.1 GENERAL

A number of significant technical and managerial accomplishments were made by Philco WDL during the course of the Advent Program. In general, the Advent administrative and engineering procedures that improved the means with which the program was completed in an efficient and cost saving manner, have been adopted by subsequent programs at Philco. Of significance, is the "sell off" of all Advent equipment to the U. S. Government. This accomplishment is outlined in the following paragraphs:

4.2 AEROSPACE GROUND EQUIPMENT

Upon completion of requirement for AGE Sets 1 and 2 on 7 and 20 December 1962, respectively, the two AGE sets were returned to Philco WDL at Palo Alto, and accountability transferred from the present Advent Contract to Contract AF04(695)-113. Acceptance (Form DD250, Numbers 2191 and 2192) was accomplished by the local AFQCR at Palo Alto on 26 December 1962. Use of this equipment to support Program 823 has been authorized.

AGE 3 was returned to Palo Alto on December 19, 1962, from Patrick /FB and was placed in storage with accountability established under the industrial property account of Contract AF04(695)-113. Acceptance (Form DD250, Number 2189) was accomplished by the local AFQCR at Palo Alto on 26 December 1962.

AGE Sets 4 and 5 were terminated by SG032 in July 1962 and considered acceptable by AFSSD TWX, SSOK 19-10-18, dated 19 October 1962 (PCC #8205). Subsequent to transfer of this equipment to the Philco WDL Industrial Account (Form DD1149, Numbers CT 00201 and CT 00192, 20 November 1962), approval was granted for utilization of any or all items to satisfy requirements of Program 823. Those items not selected by Program 823 were placed in residual storage at Philco WDL.

4.3 SATELLITE TEST ANNEX

The STA equipment was accepted (Form DD250, Number 2125) by the local AFQCR at Palo Alto on 13 September 1962. In November 1962 the equipment was returned to Philco and placed in storage with accountability established under the industrial property account of Contract AF04(695)-113.

4.4 HTS

Philco was contractually required to provide assistance through Phase IV at HTS. AFSSD direction in November advised Philco that the TT&C equipment was considered acceptable and no further work was required. Acceptance (Form DD250, Numbers 2174, 2178, 6179, and 2180) was accomplished by Lt. Col. Fisher of the 6593 Instrumentation Squadron at HTS on 14 December 1962. Upon acceptance of the equipment by the Air Force and its transfer to Contract AF04(695)-113, Philco WDL was authorized to utilize and modify any items of this equipment to support Program 823 requirements at HTS. Items of equipment not required for Program 823 at HTS were to be removed and returned to Philco WDL, Palo Alto, for storage.

4.5 FORT DLX STATION

The TT&C equipment at FDS was considered acceptable by letter "Advent Equipment at FDS and CRS, Contract AF04(695)-112," 1 January 1963, RWHS/D Cowart 301-12. Portions of Philco Phase III & IV effort were not accomplished because the feed modification performed by Sylvania did not resolve the antenna noise problem. Acceptance (Form DD250, Numbers 9519, 9520, 9521, and 9522) was accomplished by Lt. Col. W. Jordan of the 6594th Aerospace Test Wing on 11 January 1963. Upon acceptance of the equipment by the Air Force and its transfer to Contract AF04(695)-113, custodial maintenance support of two Philco technical personnel is being accomplished.

4.6 CAMP ROBERTS STATION

The letter of acceptance, transfer, and maintenance of equipment was the same as the Fort Dix Station. Acceptance (Form DD250, Numbers 9512, 9513 and 9514) was accomplished by Lt. Col. W. Jordan on January 18, 1963.

4.7 NAVY ADVENT SHIPBOARD TERMINAL

The Philco-built TT&C subsystem was installed aboard the USN Kingsport, (AG-164) by Philadelphia Naval Shipyard personnel in July and August 1962. The Philco Advent Program Office provided all installation procedures and cable and wire lists to the liaison contractor (Bendix Pacific), who provided the information to the integration contractor, Bendix System Division, who in turn delivered the information to the Boston Navy Yard. Acceptance (Form DD250, Numbers 2169, 2170 and 2172) was accomplished by Mr. N. Dalo, secondary ACO for Philadelphia, on December 7, 1962. The ship was officially presented to and accepted by the Military Sea Transportation Service on December 8, 1962.

SECTION 5

CONCLUSIONS

5.1 GENERAL

The Advent Program organization at Philco WDL has performed efficiently and effectively in managing a fast moving, multi-managed, rapidly changing program concept within a very stringent and fluctuating budget. Methods were developed and tailored specifically to Advent requirements. Manpower loading in management areas has been maintained throughout at a realistically economical level and control vigorously exerted. Philco WDL's excellent performance in the execution of their portion of the Advent contract has been acknowledged by the Customer.

Although unpredictable events prevented the Advent Program from becoming an operational system, the program did provide an excellent example of engineering management cooperation. Numerous examples of this cooperation are contained within this document.

The name Advent will no longer be heard; however, the TT&C equipment developed and delivered by Philco WDL is presently finding its way into many other satellite control systems destined to achieve operational status.

APPENDIX A
ADVENT ARCHIVES MATERIAL

NOTE: ABBREVIATIONS OR NAMES WHICH CHANGED DURING THE COURSE OF THE
ADVENT PROGRAM AND WHICH MAY CAUSE CONFUSION WHEN READING THE
LISTED DOCUMENTS ARE AS FOLLOWS:

ADVENT = 921C USAAMA = USASCA STC = STA KPS = HTS

APPENDIX A
ADVENT ARCHIVES MATERIAL

Subject

I. ADVENT PROGRAM

- A. Organizational
- B. Documentation (See also III "Documentation")
- C. Schedules and Milestones (Typical)
- D. Security
- E. Costing
- F. Preliminary Information Reports
- G. Site Addresses
- H. Reliability
- I. Trouble and Failure Reports
- J. Technical Writings (Unpublished)
- K. Study Programs
- L. Inventories - Plant 50
- M. Weekly Progress Reports
- N. Equipment Status Reports
- O. Test Equipment
- P. Spares
- Q. Minor Modifications History
- R. Technical Memos
- S. Reports (TR's, TP's) NOTE: Complete set of contractually required reports are available from Philco WDL Technical Publications Section.
- T. Motorola Equipment - Test Procedures, Progress Reports, Work Statements
- U. General Chronological Files

ADVENT ARCHIVES

II. ADVENT SITES

- A. Aerospace Ground Equipment - General Chronological Files
- B. Satellite Test Center
 - 1. Technical Directive
 - 2. Advent Control System at STC
 - 3. Satellite Control Abbreviations
 - 4. Data Line Translator - DDTE
- C. Camp Roberts Station/Fort Dix Station
 - 1. Personnel Planning Information - FDS
 - 2. Operational Common Test Equipment, FDS/CRS
 - 3. General Chronological Files
 - 4. CRS Installation Photos
- D. Hawaii Tracking Station
 - 1. Site and Installation Drawings
 - 2. TLM-18 Antenna
 - a. "Final Study Report - Automatic Tracking Telemetry/Antenna System, Model R-1104" dated 2/9/59 from Radiation Inc.
 - b. "Final Acceptance Test Report - Automatic Tracking Telemetry Antenna System, Model R-1162" dated 8/14/59 from Radiation Inc.
 - c. General Chronological File
 - d. Request for Waiver of Noise Requirements
 - e. "Final Report - Transmission Line Noise" dated 12/30/62 by R..M. Wert
 - f. Antenna Gear Problem
 - 3. Boresight Tower - General Chronological Files
 - 4. "Preliminary Study of the Conical Scan Error Signal Detection for KPS" dated 6/15/61 by M. Furukawa

ADVENT ARCHIVES

- D. 5. "Technical Provisions for Specifications - Transmitter Facilities - HTS" dated 9/8/61 by LMSC
- 6. Discoverer Timing Modifications
- 7. WDL-TR-1973, "Project Advent Electronic Interference Test Results - HTS" dated 12/31/62
- 8. WDL-TR-1653, "Table and Inventory List"
- 9. General Chronological Files
- 10. Transfer of Equipment to Program 823
- E. Naval Advent Shipboard Terminal
 - 1. Major Component Descriptions
 - 2. Vibration Evaluation
 - 3. Grounding
 - 4. Installation Photos
 - 5. Installation Drawings - BuShips
 - 6. DDTE NAST Interface
 - 7. Bendix Cabling Book
 - 8. "Engineering Cable and Wire List - NAST"
 - 9. WDL-326-4, Volume VIII, "Navy Shipboard"
 - 10. BSC 33089, "Navy Advent/Syncom Shipboard Terminal Test Equipment List" dated 7/2/62 from Bendix
 - 11. BSC 33146, "Navy Advent/Syncom Shipboard Terminal Recommended Maintenance Test Equipment" dated 7/20/62 from Bendix
 - 12. NAST Drawing Index
 - 13. General Chronological Files

III. DOCUMENTATION

- A. Equipment Sign-off (DD 250's) NAST
- B. Equipment Sign-off (DD 250's) FDS
- C. Equipment Sign-off (DD 250's) CRS

ADVENT ARCHIVES

- D. NAST Data List (Preliminary)
- E. TR-1656 (Preliminary) "Table of Equipment and Inventory List of TT & C Equipment for NAST"
- F. Final NAST Parts List
- G. Motorola Parts List
- H. Drawing List - Advent
- I. Engineering Equipment List - Advent
- J. Engineering Drawing Index - Advent
- K. Rack Elevations - Advent
- L. CPE/GFE, Facility Support, Test Equipment, etc.
- M. IBM Cards - Advent Drawing Index
- N. IBM Aperture Cards (Advent Drawings on Microfilm 95 % Complete
- O. Film Rolls - Microfilm Masters of Aperture Cards
- P. Advent Drawings - 95% Complete Set

IV. PROGRAM OFFICE FILES

- A. Associate Contractors
 - 1. Bendix Systems
 - 2. Bendix Radio
 - 3. GE-MSVD
 - 4. Sylvania
 - 5. LMSC
- B. Agencies
 - 1. Aerospace
 - 2. USASRDL
 - 3. USASCA (USAAMA)
 - 4. AFSSD
 - 5. BuShips

C. Stations

1. Fort Dix/Camp Roberts
2. NAST
3. STC
4. Kaena Point
5. AGE Sites - Sign-off, All Sites (DD 250's)

D. Systems

1. Data Subsystem
2. Display Subsystem

E. R-F Subsystem

1. Transmitting Subsystem
2. Receiving Subsystem
3. Diplexer Filters Subsystem

F. Reports

1. Weekly - Reports
2. Monthly Progress Reports

G. General

1. Incoming Correspondence Summary
2. Classified Documents Received
3. Contractual Direction - WDL

H. Interface Agreements and Rules**I. Work Orders**

1. A017 General
2. A017 Financial Sheets
3. A017 Work Orders
4. A042 General
5. A042 Financial Sheets
6. A042 Work Orders
7. A043 General
8. A043 Financial Sheets
9. A043 Work Orders
10. C601 Work Orders

J. General Program

K. Test Data

V. MANAGEMENT/SUPPORT

A. Organization and Management

B. Technical Manuals

C. Chronological Files - December 1960 to December 1962

D. Technical Reports

E. General Reading File

F. Contracts

G. Contracts Documentation

H. Proposals

I. Subcontracts

J. Procurement

K. Reports and Fiscal

L. Equipment

1. Subsystems
2. TT&C System
3. Testing
4. Specifications
5. Studies
6. Logistics
7. Reliability
8. GFE/CFE Equipment

M. Sites

1. AGE's
2. STA (STC)
3. CRS
4. FDS
5. HTS
6. NAST

N. Scheduling

O. Schedules - Weekly

P. Schedules - Monthly

Q. Work Orders

DISTRIBUTION LIST

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